

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

ABE et al.

Art Unit: Unassigned

Application No. Unassigned

Examiner: Unassigned

Filed: February 7, 2002

For: HIGH-FREQUENCY WAVEGUIDE AND  
MANUFACTURING METHOD  
THEREOF

PRELIMINARY AMENDMENT

Commissioner for Patents  
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

*IN THE TITLE:*

Replace the title with:

HIGH-FREQUENCY WAVEGUIDE AND METHOD OF  
MANUFACTURING THE WAVEGUIDE

*IN THE SPECIFICATION:*

Replace the paragraph beginning at page 1, line 4 with:

The present invention relates to a high-frequency waveguide and a method of manufacturing it, and particularly to a waveguide through which electromagnetic waves lying in a microwave band, a millimeter-wave band and a submillimeter-wave ~~bands~~ band propagate, and a manufacturing method thereof.

20067236-020702

Replace the paragraph beginning at page 1, line 10 with:

As a waveguide for allowing electromagnetic waves (hereinafter called "high-frequency waves") lying in ~~a~~ microwave, ~~a~~ millimeter-wave, and ~~a~~ submillimeter wave bands to propagate, a hybrid waveguide comprising a combination of wave guides, metals and a dielectric ~~has~~ have been used. An NRD (nonradiative dielectric) guide with a dielectric interposed between two metal plates has been used as a waveguide in which metals and a dielectric are utilized in combination. ~~As the known references, for example, there are known~~ IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-29, NO. 11, NOVEMBER 1981, PP. 1188-1192, and IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-32, NO. 8, AUGUST 1984, PP. 943-946.

Replace the paragraph beginning at page 1, line 22 with:

While the NRD guide has the feature that no radiation loss is produced at a bent portion of a waveguide, ~~a~~ propagation loss increases because it is used in the neighborhood of a cutoff frequency of the waveguide. In addition to this, a waveguide using a photonic band crystal structure has been placed under study as a waveguide low in radiation loss.

*IN THE CLAIMS:*

Replace the indicated claims with:

1. (Amended) A high-frequency waveguide comprising:

a first high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes;

a second high-frequency reflecting wall opposite, spaced from, and parallel to the first high-frequency reflecting wall, with a dielectric interposed between the first and second high-frequency reflecting walls, the second high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes; and

conductive plates which are opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates and end faces of the dielectric bars of the first and second high-frequency reflecting walls connected to the conductive plates.

5. (Amended) The high-frequency waveguide according to claim 1, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

6. (Amended) The high-frequency waveguide according to claim 2, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

7. (Amended) The high-frequency waveguide according to claims 1, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

8. (Amended) The high-frequency waveguide according to claims 2, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

9. (Amended) The high-frequency waveguide according to claims 3, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

10. (Amended) The high-frequency waveguide according to claims 4, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

11. (Amended) The high-frequency waveguide according to claims 5, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

12. (Amended) The high-frequency waveguide according to claims 6, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

13. (Amended) The high-frequency waveguide according to claim 7, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

14. (Amended) The high-frequency waveguide according to claim 8, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

15. (Amended) The high-frequency waveguide according to claim 9, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

16. (Amended) The high-frequency waveguide according to claim 10, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

17. (Amended) The high-frequency waveguide according to claim 11, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

18. (Amended) The high-frequency waveguide according to claim 12, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

19. (Amended) A method of manufacturing a high-frequency waveguide including :  
laminating dielectric bars having lengths, each dielectric bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant is lower on the axis than off axis, in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes thereby forming first and second high-frequency reflecting walls; and  
placing the first and second high-frequency reflecting walls opposite each other, parallel to each other, and spaced from each other, placing conductive plates opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates, and connecting the conductive plates to respective end faces of the dielectric bars of the first and second high-frequency walls.

20. (Amended) The method according to claim 19, further including forming metal walls outside the dielectric bars corresponding to outermost layers of the first and second high-frequency reflecting walls.

*IN THE ABSTRACT:*

Replace the Abstract with:

**Abstract of the Disclosure**

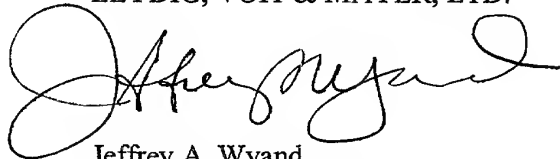
A first dielectric wall and a second dielectric wall in which hollow alumina cylindrical columns are arranged in layers so that axial centers of the alumina cylindrical columns describe planar triangular lattice arrays, are opposed to each other, and are parallel to air interposed between them. Metal plates are opposed to each other and have end faces of the alumina cylindrical columns interposed between and connected to the metal plates. The first and second dielectric walls and the metal plates are bonded to one another, as a high-frequency waveguide with reduced radiation loss, and that is inexpensive and low in transmission loss.

**REMARKS**

The foregoing Amendment corrects translational errors and conforms the claims to United States practice. No new matter is added.

Respectfully submitted,

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THEREOF

AMENDMENTS TO SPECIFICATION, CLAIMS AND  
ABSTRACT MADE VIA PRELIMINARY AMENDMENT

*Amendments to the paragraph beginning at page 1, line 4:*

The present invention relates to a high-frequency waveguide and a method of manufacturing it, and particularly to a waveguide through which electromagnetic waves lying in a microwave band, a millimeter-wave band and a submillimeter-wave bands band propagate, and a manufacturing method thereof.

*Amendments to the paragraph beginning at page 1, line 10:*

As a waveguide for allowing electromagnetic waves (hereinafter called "high-frequency waves") lying in ~~a~~ microwave, ~~a~~ millimeter-wave, and ~~a~~ submillimeter wave bands to propagate, a hybrid waveguide comprising a combination of wave guides, metals and a dielectric ~~has~~ have been used. An NRD (nonradiative dielectric) guide with a dielectric interposed between two metal plates has been used as a waveguide in which metals and a dielectric are utilized in combination. As ~~the~~ known references, ~~for example~~, there are ~~known~~ IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-29, NO. 11, NOVEMBER 1981, PP. 1188-1192, and IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. MTT-32, NO. 8, AUGUST 1984, PP. 943-946.

*Amendments to the paragraph beginning at page 1, line 22:*

While the NRD guide has the feature that no radiation loss is produced at a bent portion of a waveguide, ~~a~~ propagation loss increases because it is used in the neighborhood of

a cutoff frequency of the waveguide. In addition to this, a waveguide using a photonic band crystal structure has been placed under study as a waveguide low in radiation loss.

*Amendments to existing claims:*

1. (Amended) A high-frequency waveguide, comprising:

a first high-frequency reflecting wall ~~wherein including dielectric bars of predetermined having lengths, which respectively comprise each bar comprising a plurality of dielectric constant different~~ columnar bodies having respective axes and concentrically disposed varying dielectric constants so that the dielectric constants constant on the axial center sides thereof become low axis is lower than off the axis, are the dielectric bars being disposed in the form of plural layers so that the axial centers axes of the dielectric bars have planar regularities describe corners of a regular polygon in a plane perpendicular to the axes;

a second high-frequency reflecting wall ~~which is opposite, spaced from, and parallel to the first high-frequency reflecting wall in parallel, with a dielectric interposed therebetween and wherein~~ between the first and second high-frequency reflecting walls, the second high-frequency reflecting wall including dielectric bars of predetermined having lengths, which respectively comprise each bar comprising a plurality of dielectric constant different columnar bodies having respective axes and concentrically disposed varying dielectric constants so that the dielectric constants constant on the axial center sides thereof become low axis is lower than off the axis, are the dielectric bars being disposed in the form of plural layers so that the axial centers axes of the dielectric bars have planar regularities describe corners of a regular polygon in a plane perpendicular to the axes; and

conductive plates which are opposite to each other, ~~with the end faces of the dielectric bodies constituting the first and second high-frequency reflecting walls being interposed therebetween~~ between the conductive plates and which are respectively connected to both end faces of the dielectric bars constituting of the first and second high-frequency reflecting walls connected to the conductive plates.

5. (Amended) The high-frequency waveguide according to claim 1, ~~wherein a the dielectric lying interposed~~ between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

6. (Amended) The high-frequency waveguide according to claim 2, ~~wherein a the dielectric lying interposed~~ between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.



7. (Amended) The high-frequency waveguide according to claims 1, ~~wherein~~  
including metal walls are further provided located outside the dielectric bars and  
corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

8. (Amended) The high-frequency waveguide according to claims 2, ~~wherein~~  
including metal walls are further provided located outside the dielectric bars and  
corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

9. (Amended) The high-frequency waveguide according to claims 3, ~~wherein~~  
including metal walls are further provided located outside the dielectric bars and  
corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

10. (Amended) The high-frequency waveguide according to claims 4, ~~wherein~~  
including metal walls are further provided located outside the dielectric bars and  
corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

11. (Amended) The high-frequency waveguide according to claims 5, ~~wherein~~  
including metal walls are further provided located outside the dielectric bars and  
corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

12. (Amended) The high-frequency waveguide according to claims 6, ~~wherein~~  
including metal walls are further provided located outside the dielectric bars and  
corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

13. (Amended) The high-frequency waveguide according to claim 7, wherein the  
metal walls respectively comprise metal bar arrays in which metal bars substantially identical  
in length to the dielectric bars are disposed along the dielectric bars.

14. (Amended) The high-frequency waveguide according to claim 8, wherein the  
metal walls respectively comprise metal bar arrays in which metal bars substantially identical  
in length to the dielectric bars are disposed along the dielectric bars.

15. (Amended) The high-frequency waveguide according to claim 9, wherein the  
metal walls respectively comprise metal bar arrays in which metal bars substantially identical  
in length to the dielectric bars are disposed along the dielectric bars.

16. (Amended) The high-frequency waveguide according to claim 10, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

17. (Amended) The high-frequency waveguide according to claim 11, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

18. (Amended) The high-frequency waveguide according to claim 12, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

19. (Amended) A method of manufacturing a high-frequency waveguide, including the steps of:

laminating dielectric bars of predetermined having lengths, each dielectric bar comprising a plurality of ~~dielectric constant different~~ columnar bodies having respective axes and concentrically disposed varying dielectric constants so that ~~their the dielectric constants become low~~ constant is lower on the axial center sides thereof axis than off axis, in the form of such plural layers so that the centers axes of the dielectric bars have planar regularities to describe corners of a regular polygon in a plane perpendicular to the axes thereby form forming first and second high-frequency reflecting walls; and

~~opposing~~ placing the first and second high-frequency reflecting walls ~~to opposite each other, in parallel to each other, and spaced from each other, opposing~~ placing conductive plates ~~to opposite each other, with end faces of the dielectric bars constituting the first and second high-frequency reflecting walls being interposed therebetween between the~~ conductive plates, and connecting the conductive plates to ~~both~~ respective end faces of the dielectric bars ~~constituting of the first and second high-frequency walls respectively.~~

20. (Amended) The method according to claim 19, further including ~~a step of~~ forming metal walls outside the dielectric bars corresponding to ~~the~~ outermost layers of the first and second high-frequency reflecting walls.

*Amendments to the abstract:*

#### **Abstract of the Disclosure**

A first dielectric wall and a second dielectric wall in which hollow alumina cylindrical columns are arranged in ~~a layered form~~ layers so that ~~the~~ axial centers of the

alumina cylindrical columns ~~have~~ describe planar triangular lattice arrays, are opposed to each other, ~~in and are parallel with to air interposed therebetween~~ between them. Metal plates are opposed to each other ~~with both and have~~ end faces of the alumina cylindrical columns ~~constituting the first dielectric wall and the second dielectric wall being interposed therebetween~~ between and connected to the metal plates. ~~Further, the~~ The first and second dielectric walls ~~and~~ and the metal plates are bonded to one another, ~~whereby as a high-frequency waveguide is configured which is with reduced in radiation loss, and that is~~ inexpensive and low in transmission loss.

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AND MANUFACTURING METHOD  
THEREOF

Art Unit: Unassigned

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**PENDING CLAIMS AFTER ENTRY OF PRELIMINARY AMENDMENT**

1. A high-frequency waveguide comprising:

a first high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes;

a second high-frequency reflecting wall opposite, spaced from, and parallel to the first high-frequency reflecting wall, with a dielectric interposed between the first and second high-frequency reflecting walls, the second high-frequency reflecting wall including dielectric bars having lengths, each bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant on the axis is lower than off the axis, the dielectric bars being disposed in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes; and

conductive plates which are opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates and end faces of the dielectric bars of the first and second high-frequency reflecting walls connected to the conductive plates.

2. The high-frequency waveguide according to claim 1, wherein the dielectric bars are cylindrical.

3. The high-frequency waveguide according to claim 1, wherein the dielectric bars are hollow.

4. The high-frequency waveguide according to claim 2, wherein the dielectric bars are hollow.

5. The high-frequency waveguide according to claim 1, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

6. The high-frequency waveguide according to claim 2, wherein the dielectric interposed between the first high-frequency reflecting wall and the second high-frequency reflecting wall is air.

7. The high-frequency waveguide according to claims 1, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

8. The high-frequency waveguide according to claims 2, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

9. The high-frequency waveguide according to claims 3, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

10. The high-frequency waveguide according to claims 4, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

11. The high-frequency waveguide according to claims 5, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

12. The high-frequency waveguide according to claims 6, including metal walls located outside the dielectric bars and corresponding to outermost layers of the first and second high-frequency reflecting walls.

13. The high-frequency waveguide according to claim 7, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

14. The high-frequency waveguide according to claim 8, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

15. The high-frequency waveguide according to claim 9, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

16. The high-frequency waveguide according to claim 10, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

17. The high-frequency waveguide according to claim 11, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

18. The high-frequency waveguide according to claim 12, wherein the metal walls respectively comprise metal bar arrays in which metal bars substantially identical in length to the dielectric bars are disposed along the dielectric bars.

19. A method of manufacturing a high-frequency waveguide including :  
laminating dielectric bars having lengths, each dielectric bar comprising a plurality of columnar bodies having respective axes and concentrically varying dielectric constants so that the dielectric constant is lower on the axis than off axis, in plural layers so that the axes of the dielectric bars describe corners of a regular polygon in a plane perpendicular to the axes thereby forming first and second high-frequency reflecting walls; and  
placing the first and second high-frequency reflecting walls opposite each other, parallel to each other, and spaced from each other, placing conductive plates opposite each other, with the first and second high-frequency reflecting walls interposed between the conductive plates, and connecting the conductive plates to respective end faces of the dielectric bars of the first and second high-frequency walls.

20. The method according to claim 19, further including forming metal walls outside the dielectric bars corresponding to outermost layers of the first and second high-frequency reflecting walls.

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